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Poster Presentation

Development of a Safer Tranquilizer Dart

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ABSTRACT: Tranquilizer darts are designed to administer a compound from a distance, utilizing low velocities to minimize unnecessary injury to the animal by excessive penetration of the dart. As a result, effective distances and subsequent accuracy of the dart are problematic. It was hypothesized that a minor modification to commercially-available tranquilizer darts would allow greater velocities to be utilized by reducing some of the impact force. This should increase the effective distance of the darts while reducing potential damage to target animals if higher velocities were utilized. A foam-based conventional earplug was modified by cutting it in half to fit over a tranquilizer dart needle. Velocity and calculated impact energy produced from 2.0-cc practice transmitter darts were recorded for treatment and control darts projected at a distance of 13.72 m at two velocities. Degree of dart penetration into a block comprised of layers of a foam insulation material was recorded. Relative accuracy of darts was also collected. While no differences were observed in dart accuracy, velocity, or projected impact energy ($p > 0.05$), penetration of darts into the insulation block at the higher test velocity was lower ($p < 0.05$) for treatment darts (11.82 ± 0.30 cm) compared to controls (13.17 ± 0.36 cm). However, dart penetration into the hip of a euthanatized dog was similar ($p > 0.70$) between the treatment (2.21 ± 0.77 cm) and controls (2.68 ± 0.96 cm) at the higher velocity. It also appeared that degree of dart penetration was highly influenced by the angle of impact relative to the tissue. Based on dart penetration results in animal tissue, the foam based dart modification was not an effective method to reduce impact force of tranquilizer darts.

KEY WORDS: impact force, dart modification, tranquilizer dart, wildlife capture

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INTRODUCTION

A common method to capture free-ranging animals is the use of tranquilizer darts for inducing chemical restraint. Darting allows the capture of selective animals over a wider range of sites than do commonly used methods such as traps, snares, and nets (Haulton et al. 2001). Darting of animals is used when physical restraint of an animal is impossible or dangerous (Loyau and Szczepaniak 2006).

One problem associated with the use of tranquilizer darts is excessive penetration if projected at too high a velocity. Valkenburg and Tobey (2001) determined that 7-cc darts using a moderate level .22-caliber blank cartridge (brass #3), commonly used on grizzly bears, can completely pass through 1.25-cm plywood. This velocity has the potential to cause severe injuries in animals with thinner skin or if projected at too close a distance. Liscinsky et al. (1969) determined that a 2-inch dart can penetrate up to 1 inch into an animal. Additionally, permanent wound cavities on animals have been reported up to 3 times the length of the needle of the dart (Cattet et al. 2006). Montgomery (1961) designed a dart from copper or brass tubing that occasionally penetrated up to 2½ inches below the skin of deer. This deep penetration caused long-term injuries that decreased animal's survivability.

Dart modifications could improve accuracy over longer distances while minimizing impact injuries. Shryer (1971) designed a smaller dart that could be shot with less velocity for small animals, but only has a range up to 20 yds. One method to increase effective range of a tranquilizer dart is increasing projection velocity. Unfortunately, utilization of excessive projection velocity at a given target range increases the chance of excessive penetration of the dart and subsequent animal injury. Therefore, the purpose of this study was to determine if a minor modification to a tranquilizer dart intended to decrease impact force could be accomplished without altering flight characteristics.

METHODS

Dart Tip Design

A standard commercial foam based earplug (Jackson Safety, Belmont, MI) was used to create the treatment tips. The earplug was cut approximately in half (1.4 cm) using a razor blade. A hole was then formed in the top half of the ear plug by using a heated 18-gauge needle. This allowed the tip to be placed over the dart needle and secured to the base of the needle using a small drop of a cyanoacrylate glue (Krazy Glue, Elmers Products Inc., Columbus, OH). Darts without the foam tip served as controls.

Ballistics Analysis

Relative accuracy, velocity, and penetration depth of 2.0-cc practice transmitter darts (Pneu-Dart, Inc., Williamsport, PA), projected from a distance of 13.72 m at two velocities, were collected for both control and treatment darts. A .22-caliber cartridge-based dart gun (Model 193, Pneu-Dart, Inc., Williamsport, PA), was placed on a portable bench rest and operated by a single individual within an indoor facility, to minimize environmental influences on dart flight characteristics. Dart velocity was measured using a radar gun (Stalker Pro Digital Sports Radar, Plano, TX). Dart velocity data and average weight of the darts were used to calculate kinetic energy (impact energy). Acceptable accuracy was based on the dart impacting an area within a 15.24-cm diameter circle of the intended target.

The darts were fired into 5 pieces of 61 × 61-cm squares of 1.9-cm-thick foam-based insulation (Owens Corning, Toledo, OH) duct taped together to form a block. The insulation block was placed in front of a piece of plywood, against a metal wall, to provide a solid backing. Ten control darts and ten treatment darts were shot in an alternating manner, using projector settings based upon manufacturer (www.pneudart.com) recommendations designed to provide an acceptable velocity for the size of dart relative to the intended target distance. The low (recommended) velocity was obtained by using a .22-caliber blank, brass #3 (green) charge, with the gas port setting at level 3 (1 = lowest, 5 = highest). The high-velocity setting utilized the same .22-caliber charge with the gas port setting at level 4. The barrel of the dart gun was cleaned with a cotton patch after each shot. Complete disassembly and cleaning of the projector occurred after each 10 rounds.

The distance from the surface of the insulation block to the tail end of the dart was measured. Depth was determined by subtracting this amount from the dart's length. Data were analyzes using SPSS ANOVA procedures for main effects of dart velocity, kinetic energy, and depth of penetration. Duncan's Multiple Range analysis was incorporated to examine differences within main effects (SPSS 17.0, Chicago, IL).

Animal Tissue Test

A large (40 kg), short-haired mixed breed dog was utilized to evaluate the dart penetration in animal tissue. The male dog was euthanized at the regional county animal control center and transported to the Berry College campus. Dart penetration data collection was initiated within 20 minutes post-mortem. The hip of the canine was the designated target site and subsequently positioned on a surgical table at approximately 2 m from the barrel tip of the .22-caliber dart gun. The dart gun was operated in a similar manner to the initial testing on the foam blocks.

The higher velocity settings (brass #3, gas port setting 4) previously described was used for the tissue penetration testing. A total of 10 control and 10 treatment darts (2.0-cc practice transmitter darts) were projected alternately into the left and right hip, with a minimum of 2.54 cm distance between impact locations. Depth of penetration into the animal tissue was analyzed using SPSS ANOVA procedures.

RESULTS AND DISCUSSION

There was no difference ($p > 0.05$) in average speed between control and treatment darts at the low projection velocity (41.14 ± 0.67 m/sec, 40.38 ± 0.53 m/sec, respectively) into the insulation block. As a result, predicted energy of impact was also similar between control (10.28 ± 0.35 ft. lbs.) and treatment groups (10.04 ± 0.26 ft. lbs.). These kinetic energy values are similar to those previously reported (Gallagher 2006), and are a direct reflection of the manufacturer's published projector settings for this dart/distance combination. Depth of dart penetration into the block was also similar ($p > 0.05$) between the control (7.61 ± 0.21 cm) and treatment (7.79 ± 0.13 cm). This would suggest that the treatment dart modification did not impede impact energy required for normal dart operation, nor influence accuracy.

At the higher dart projection rate, treatment darts flew at 57.10 ± 1.00 m/sec compared to the controls 58.48 ± 0.67 m/sec, and were similar ($p > 0.05$). The projected impact energy was also similar ($p > 0.05$) between the treatment and controls (20.09 ± 0.71 ft. lbs, 20.74 ± 0.47 ft. lbs., respectively). This level of kinetic energy is approaching twice the projected impact energy at this distance compared to what would be expected at the manufacturer projection velocities (Gallagher 2006). However, there was less penetration ($p < 0.05$) of the treatment darts (11.82 ± 0.30 cm) compared to the controls (13.17 ± 0.36 cm) into the insulation block. Accuracy of the treatment and control darts were similar and acceptable with both velocities.

These results indicate that utilization of the foam tip decreased level of penetration of the dart while not influencing dart flight characteristics. This would suggest the foam tip or similar devices had potential in reducing animal injury when utilizing remote chemical capture techniques.

While not influencing observed accuracy, several treatment darts appeared to enter the insulation block at a slight angle resulting in creating an oblong hole as opposed to a more common circular impact hole. This effect is likely due to slight irregularities resulted from cutting of the foam material or in mounting the material on the dart. This could potentially decrease the degree of penetration observed, due to increased friction effects of the dart upon impact with the insulation block.

Regardless, dart penetration into the hip of a euthanized dog was similar ($p > 0.70$) between treatment (2.21 ± 0.77 cm) and control (2.68 ± 0.96 cm) darts at the relatively high velocity. It also appeared that penetration of the dart was highly influenced by the angle of impact relative to the tissue. This was illustrated by the tremendous range in depth of penetration of both the control (0 - 10.1 cm, SD = 3.72) and treatment (0 - 8.8 cm, SD = 2.88) darts projected at the same velocity. While the angle was not measured, it appeared that greater penetration of darts regardless of treatment occurred the more perpendicular the orientation of the dart gun barrel to the animal's hip.

While results of penetration tests of the modified darts were encouraging for the block of insulation, subsequent testing on animal tissue suggests the concept would not be effective in accomplishing the objective of reducing dart impact force in live animals.

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